CLAIMS

1. A method of forming uniform metal nitrides (MN) comprising contacting heated metal with hydrogen iodide (HI) or iodine (I_2) vapor, at pressures below 760 Torr, to form a metal iodide (MI) and then contacting said MI with ammonia, at pressures below 760 Torr, to form said MN.
2. The method of claim 1 conducted in a reactor wherein the reactor pressure is maintained between 750 and 75 Torr.
3. The method of claim 1 wherein said reduced pressures are between 600-100 Torr.
4. The method of claim 1 wherein said reduced pressures are between 100-5 Torr.
5. The method of claim 1 wherein said M is gallium, aluminum, indium or alloys thereof.
6. The method of claim 1 wherein said MN is gallium nitride (GaN), aluminum nitride (AlN), indium nitride (InN) and ternary and quaternary nitrides such as gallium aluminum nitride (GaAlN), gallium arsenic nitride (GaAsN), gallium aluminum indium nitride (GaAlInN) or gallium arsenic indium nitride (GaAsInN).
7. The method of claim 1 wherein said MI is formed in one locale and then is flowed to another locale to react with ammonia to form said MN.
8. The method of claim 1 wherein said MN is formed as a vapor and deposited on a substrate or a seed or self-nucleates on a nearby surface.
9. The method of claim 1 wherein
    a) iodine is placed in a first boat upstream in an elongated first container below an inlet for H_2 or HI,

b) metal is placed in a second boat located downstream of said first boat in said first container, with an outlet thereof being positioned downstream of said second boat,

c) heating said second boat to heat the metal therein,

d) heating said first boat to cause iodine vapor to flow downstream to contact said metal to form MI vapor or flowing said HI from said inlet downstream to contact said metal to form MI vapor,

e) flowing said MI vapor out said outlet and

f) contacting said MI vapor with said ammonia to form said MN.

10. The method of claim 9 wherein a substrate is positioned proximate said outlet in a substrate zone and said MN is deposited on said substrate.

11. The method of claim 10 wherein MN formation is conducted at 750-3 Torr in said substrate zone.

12. The method of claim 9 wherein the outlet of said first container projects into or near a second container having ammonia therein and flowing said MI into said second container to contact said ammonia and form an MN vapor for deposit on a substrate, on one or more seeds or to self-nucleate on the interior surfaces of said second container.

13. The method of claim 1 wherein said MI is formed by the reaction:

$$I_2 + 2\,M \rightarrow 2\,MI \qquad \text{or by}$$

$$2\,HI + 2M \rightarrow 2\,MI + H_2$$

14. The method of claim 1 wherein said MN is formed by the reaction;

$$MI + 4\,NH_3 \rightarrow MN + 4\,H_2 + N_2 + NH_4I$$

15. A reactor for forming a metal nitride (MN) comprising,

a) a first container,

b) said container having an upstream inlet, followed by a first boat for iodine (I_2), a second boat for M spaced downstream from said first boat and an outlet located downstream from said second boat,

c) means to reduce the pressure in said container to below 760 Torr,

d) means for heating the two boats,

e) means for flowing iodine vapor from said first boat or for flowing hydrogen iodide (HI) from said inlet downstream to said second boat to contact said M to form metal iodide (MI) vapor and for flowing said MI vapor out said outlet and

f) means to contact the outlet MI vapor with ammonia to form said MN.

16. The reactor of claim 15 having a substrate positioned proximate said outlet and means to deposit said MN vapor on said substrate as a film or layer.

17. The reactor of claim 15 wherein the outlet of said first container extends into a proximate second container which holds ammonia and means for flowing said MI vapor into said second container to form MN vapor and to deposit said MN vapor on a substrate or on one or more seeds or to self-nucleate on the walls of said second container, and vacuum pump means being applied to said second container, downstream of the depositing MN vapor.

18. The reactor of claim 17 wherein a substrate is mounted in said second container proximate said outlet for deposit of said MN thereon.

19. The reactor of claim 17 wherein said first and second containers are elongated.